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Lifelong Learning Programme

CerORGANIC

# CerOrganic Training Curriculum

# Module C534

# Unit C534a.6

504387-LLP-1-2009-1-GR-LEONARDO-LMP

Co-funded by the European Union,
through the Leonardo da Vinci Programme

# Structure

1. Introduction
   i. Tutor information
   ii. Aims & objectives
   iii. Learning outcomes & skills
   iv. Methodology & media
2. Main Part
   i. Glossary
   ii. Presentation
1. Conclusion
   i. Summary
   ii. References

# 1.i. Tutor information

Awarded BSc in Agriculture from the Aristoteleon University of Thessaloniki, and an MSc and Ph.D from Michigan State University U.S.A. Worked as: Professor of Pomology and Director of School of Agriculture - Higher Technical Education Centre, Heraklion, Crete, Professor of Pomology, College of Agricultural Science, Athens, Professor of Pomology, Aristotle University, Thessaloniki. Other activities: Participated in teaching of short courses organized by CIHEAM such as Postharvest Physiology at MAICh, a short course on "Postharvest Technologies of Horticultural Crops in the Compexe Horticole D'Agadir and on rainfed Agriculture in Cyprus. Visiting professor at the University of Jordan-Amman. Consultant for 2 months at Deutche Gesellschaft für Technische Zusammenarbeit (GTZ) GMBH, and 12 months at Agrar und Hydrotechnik GMBH (AHT) in the Zarqua River Basin Development Project of the Ministry of Agriculture of Jordan. His research activities covered a broad range of Plant Physiology, biochemistry, horticulture and sustainable agriculture. He served as major professor for 17 graduate students completing Ph.D degrees., and 20 graduate students leading to MSc Has authored more than 100 articles in peer-reviewed journals in the fields of Horticulture, Plant Physiology and Biochemistry and 5 textbooks used for University and Higher Education Institutions.

# 1.ii. Aims & objectives

- To present different postharvest handling operations for specific crops of the trainees choice - preferably of relevance to the trainees own country, and propose improvements to meet the needs of organic production in this particular field.
- To offer various e-resources as an introduction to sustainable postharvest handling for organic crops.
- To demonstrate the inter-relationship of various components and effects following specific actions and postharvest practices.
- To illustrate problems and problem-solving approaches for crop-specific case studies.
- To analyze specific consultation tools for this particular domain.

# 1.iii. Learning outcomes & skills

By the end of the component, the students are expected to:

- Have an understanding of the complexity of the whole chain production system of agricultural crops,
- be competent in searching for resources in the literature and the internet,
- be familiar with several problems occurring in the field of sustainable postharvest systems,
- be able to analyze critically various solutions leading to decision-making to choose the proper marketing system, towards a sustainable approach,
- demonstrate knowledge of the requirements for post-harvest handling of horticultural produce
- have developed consultation skills on postharvest handling and marketing operations.

# 1.iv. Methodology & media

The Unit is composed of:

- e.lectures based on PowerPoint presentations “Sustainable Postharvest handling for organic crops”
- web-based literature review
- textbooks, articles
- (team) field work
- group interaction and discussion
- assignment writing

# 2. Main part

# 2.i. Glossary

**Abscission** the separation of leaves, flowers and fruits by the formation of special (abscission) layer of cells.

**Maturation** the fruit reaches a physiological stage which must be reached before the fruit may be removed from the mother plant and yet still continues to develop until it is suitable for consumption

**Ripening** The process that occur in a physiologically mature fruit from an unfavorable state of firmness, flavor and aroma to more favorable state of consumption

**Respiratory climacteric** the market increased in respiration rate shown in some fruits as they ripen.

**Senescence** (fruit) those process that follow ripening which cause a deterioration in eating quality and eventually lead to the death of the tissue.

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# 2.ii. Presentation

# Sustainable Post-harvest handling of CerOrganic horticultural products

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# Complexity of the whole chain production system

Harvesting

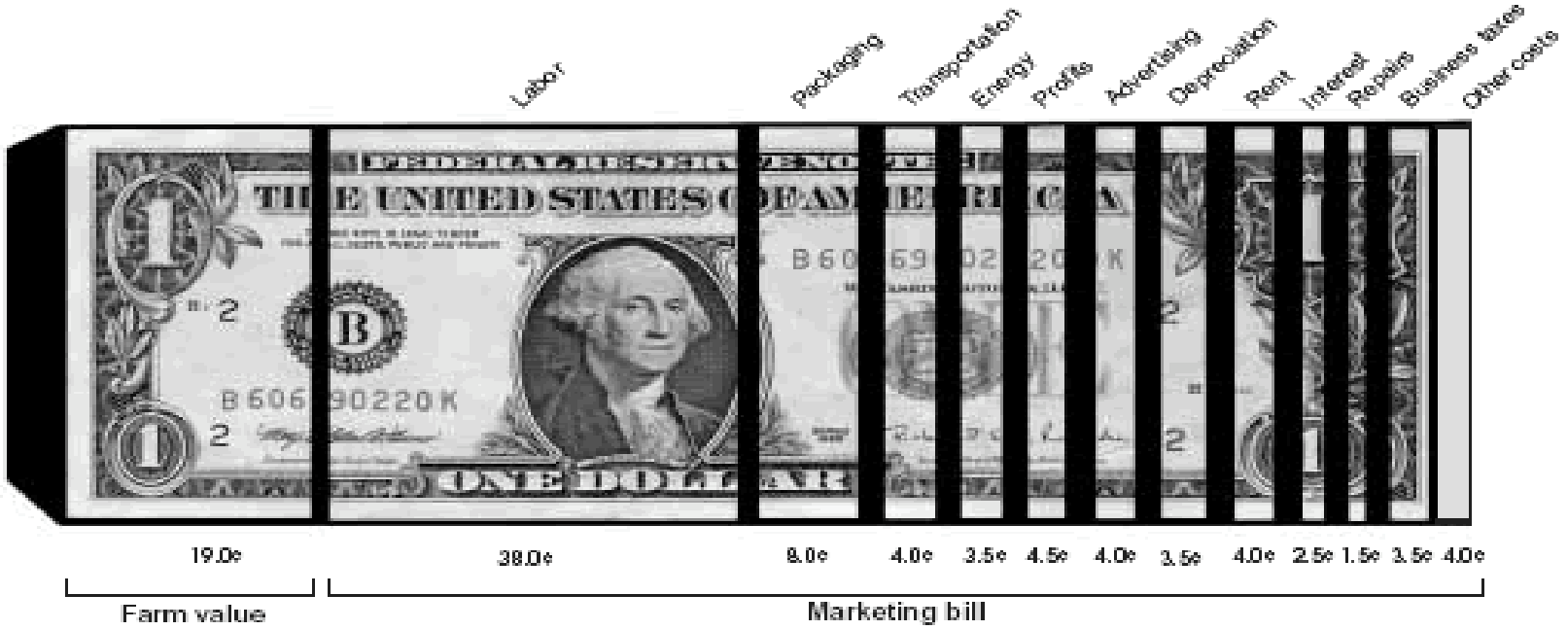
Packaging

Storage

Transportation

Marketing

# Consideration should be given to postharvest handling operations




Source: USDA's Economic Research Service.

Cultivation
Primary production

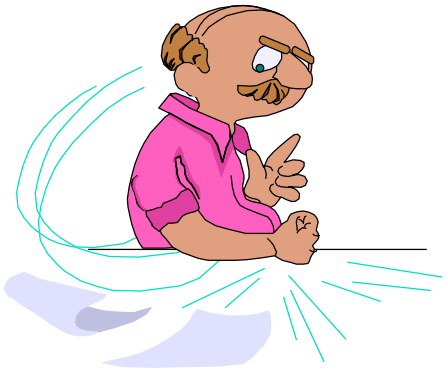
Postharvest handling operations (labor, packaging, storage, transportation, wholesale, retail marketing (81%)

Production — Harvesting, storage, packaging, transportation, distribution to wholesale-retail market

http://attra.ncat.org/attra-pub/PDF/valueovr.pdf

# Part I

## Problems and Constrains to consider when decide to change from conventional to organic production (in reference to PH handling operations of horticultural commodities)



# Key and Limited factors to consider:

1. Maintaining quality
2. Postharvest (PH) losses
3. The waste problem
4. Inputs of energy and water
5. The Safety issue
6. Lack of technical information
7. The lack of protocols for specific horticultural crops and new products
8. Store small quantities and the wide range of produce.

# Post-harvest losses

## On farm causes losses

Primary production

- Damage can be caused by: too much rain or irrigation, too little water; abnormal ripening, excess fertilizer and other factors.

Discarded tomatoes on a compost heap at nurseries

# Causes of losses **after harvest** by:

**PH handing**: High temperature, low atmospheric humidity and physical injury (careless handling, causing internal bruising, splitting and skin breaks, thus rapidly increasing

Water loss from transpiration.

Water loss causes from shrinkage and loss of weight.

Respiration uses stored starch or sugar and stops when reserves of these are exhausted, leading to ageing.

Diseases caused by fungi and bacteria cause losses.

Wholesale market

# CAUSES OF DETERIORATION

- Metabolic changes
- Growth and development
- Mechanical injuries
- Moisture loss (transpiration)
- Physiological breakdown
- Pathological breakdown

# Example 1. Losses are due to onion and potato growth - sprouting



In conventional PH handling to reduce losses :

For potato or onions sprouting use chemical treatments:

growth inhibitors

Maleic hydrazide (MH) or chlorpropham (CIPC))

For CerOrganic

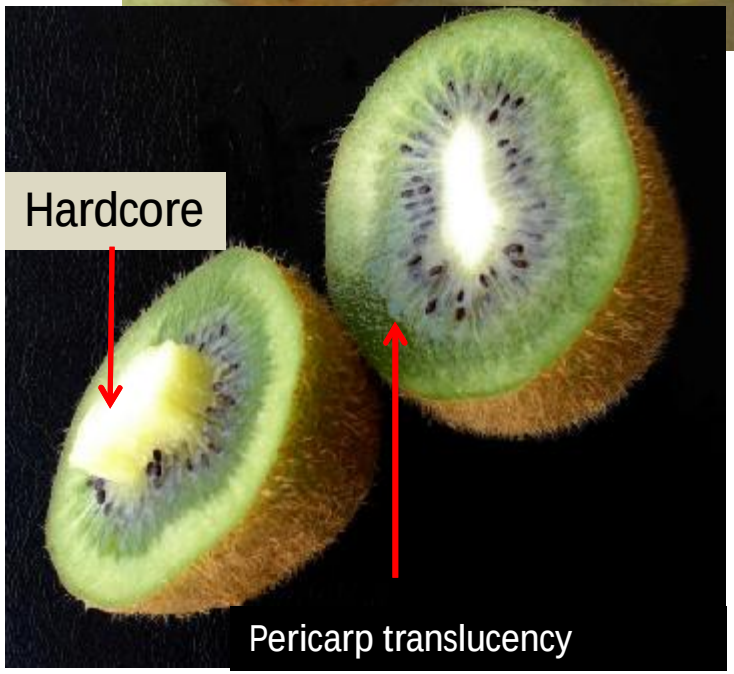
?

# Example 2. Physiological disorders in apples and kiwifruit



## In CerOrganic

?

# The superficial scald problem in apples

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Scald on Granny Smith


In CerOrganic

?

To control Scald in conventional storage
apply Diphenylamine (DPA) solution

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# Example 3. Chilling injuries Tropical -Subtropical species



20°C 10°C->20°C 0°C->20°C

Ethylene yellowing

High $CO_2$ injury

# The ethylene problem

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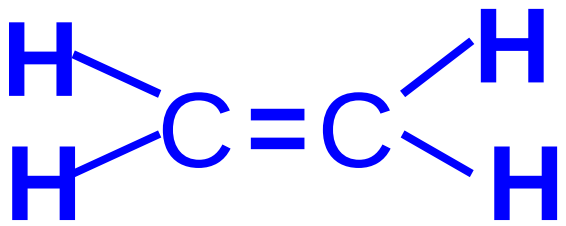
## Detrimental effects of ethylene




Degrening of leafy vegetables


Sleepiness of carnations
Petal abscission

Yellowing accelerated softening in fruits
Flower yellowing and opening in broccoli

Enhancement of PH diseases

http://www.ethylene-sa.co.za/about.html

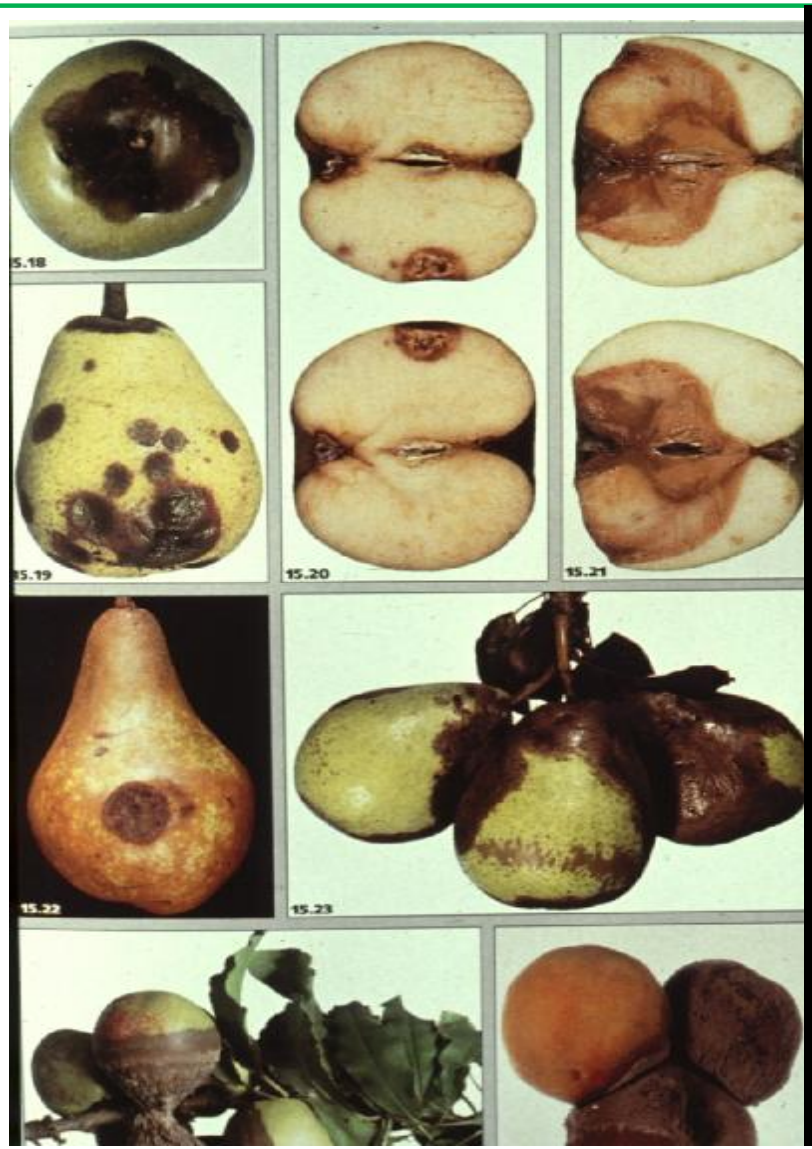
# PATHOLOGICAL LOSSES



*Alternaria*

*Cladosporium*

*Phyalophora*



*Phomopsis*

*Phytopthora*

*Monilinia*

# The consumer safety issue in organic products

The safety focused on:

- Pesticide residues
- Inorganic content (heavy metals, nitrate)
- microbiological source (E. coli, Salmonella, Listeria et.)
- Natural toxins-Micotoxins (patullin, alfatoxin et.)

1.Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data set
2.POSTHARVEST HANDLING FOR ORGANIC CROPS

# Inputs of chemicals in PH handling operations

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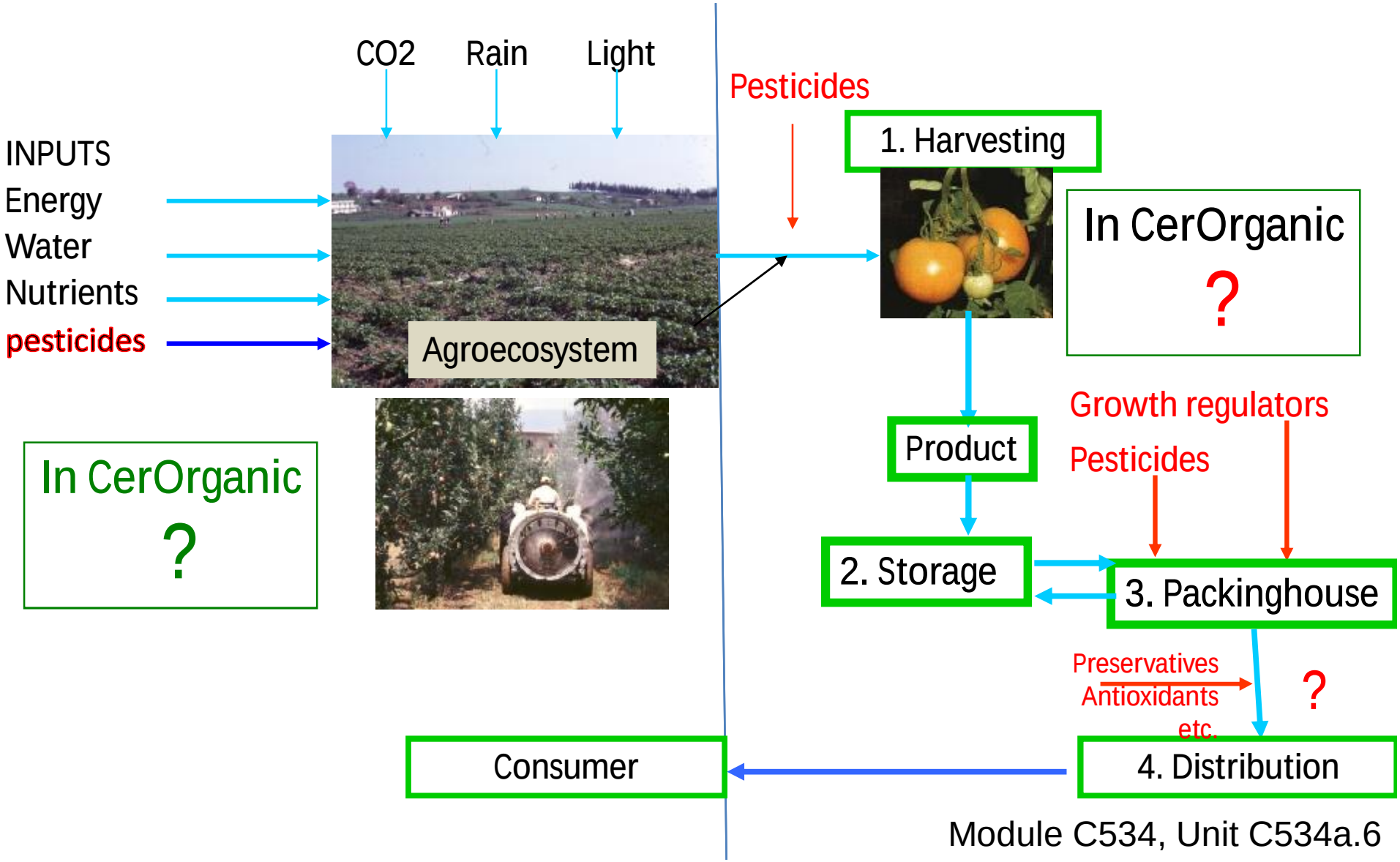


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# The energy problem in postharvest operations

# The waste problem

Primary production

- Food waste differs from post-harvest loss in that it usually results from a conscious decision to destroy food.

In the commercial marketing chain waste can occur at all stages, often as a result of the buying practices of supermarkets

Supermarkets and other retailers may throw food away when it reaches its “sell by” date.

Discarded tomatoes on a compost heap at nurseries

# The waste problem in olive processing of organic olive production

# Lack of protocols in PH handling operations

## Seed sprouts

## Fresh-cut

1. http://www.avrdc.org/LC/mungbean/sprouts/sprouts.html
2. http://ucanr.org/freepubs/docs/8060.pdf
3. http://nwrec.hort.oregonstate.edu/beansprt.html

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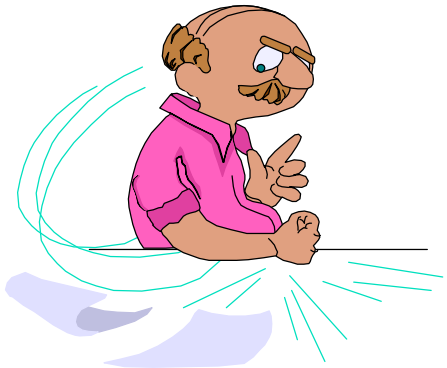
# Part II:
# Principles in Sustainable Post-harvest handling of CerOrganic horticultural products



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# Critical analysis to develop consultation skills

1. Re-examining the PH handling operations under the umbrella of sustainable organic production

2. Define the targets of sustainable Postharvest (PH) handling system to keep fruit quality and at the same time meet the commitment for the environment (improve energy efficiency, decreasing the carbon footprint) and optimize the food safety.

3. Examine the potential of traditional and new PH technologies to meet the requirements for sustainable CerOrganic production.

4. Demonstrate knowledge of the requirements for post-harvest handling of horticultural produce

# 1. Re-examining the PH handling operations under the umbrella of sustainable organic production

# Is organic production sustainable?

Sustainability in organic farming must be seen in a holistic sense, which includes ecological, economical and social aspects. Only if the three dimensions are fulfilled, an agricultural system can be called sustainable.

1. organic/sustainable agriculture
2. http://www.biodynamic.org.nz.
3. http://www.bio-gro.co.nz
4. Organic Standards
5. Sustainability Standards Building on Organic Systems

# What does sustainability mean for Organic?

- Improves competiveness
- Potential challenge to organic value
- Adding values to organic products
- Opportunity, and urgency, to advocate for organic practices as a baseline
- Impetus to measure & communicate sustainability
- benefits of organic systems, and practices from farm to the distribution chain.

# Added value beyond the farm gate

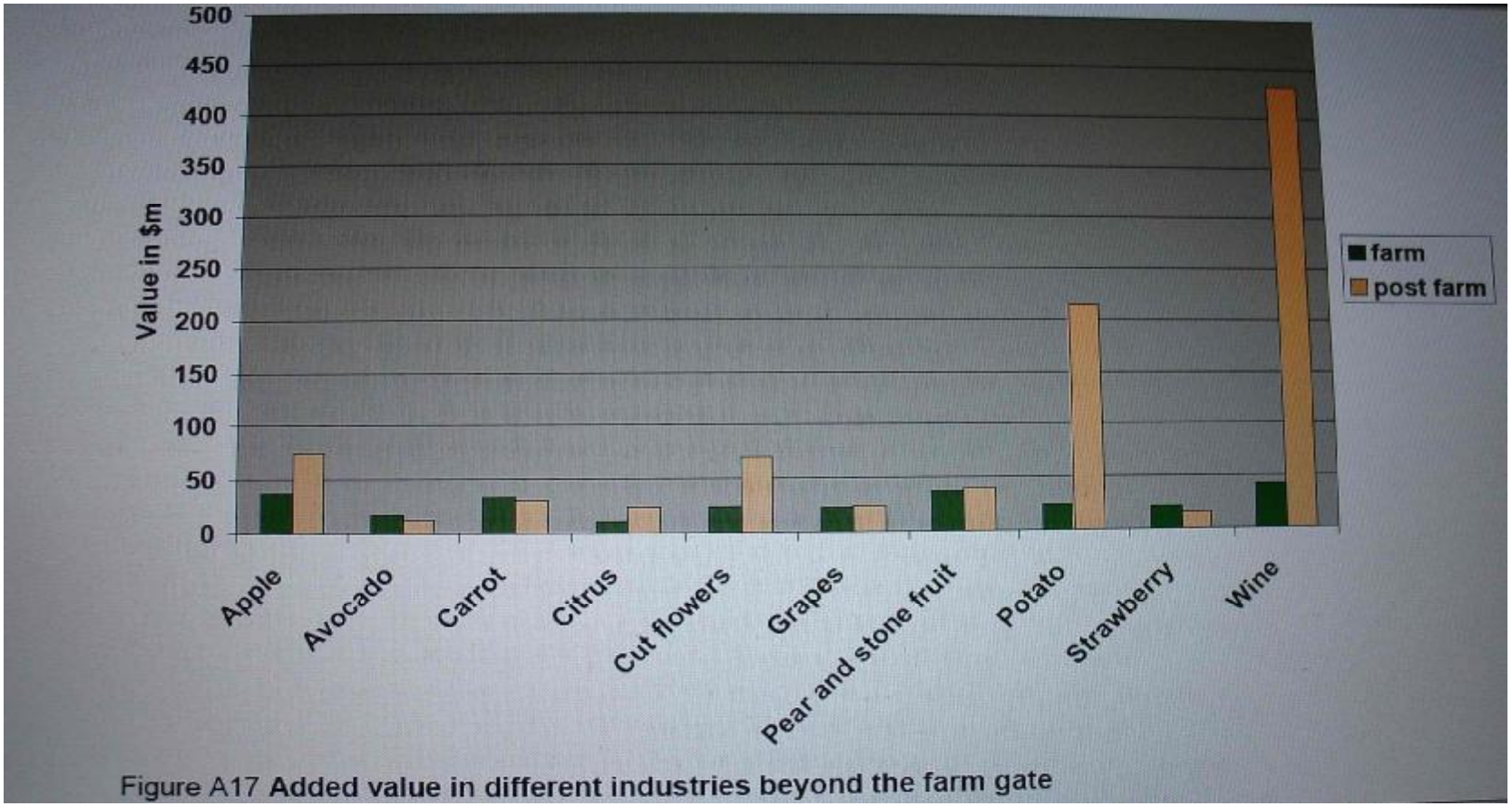
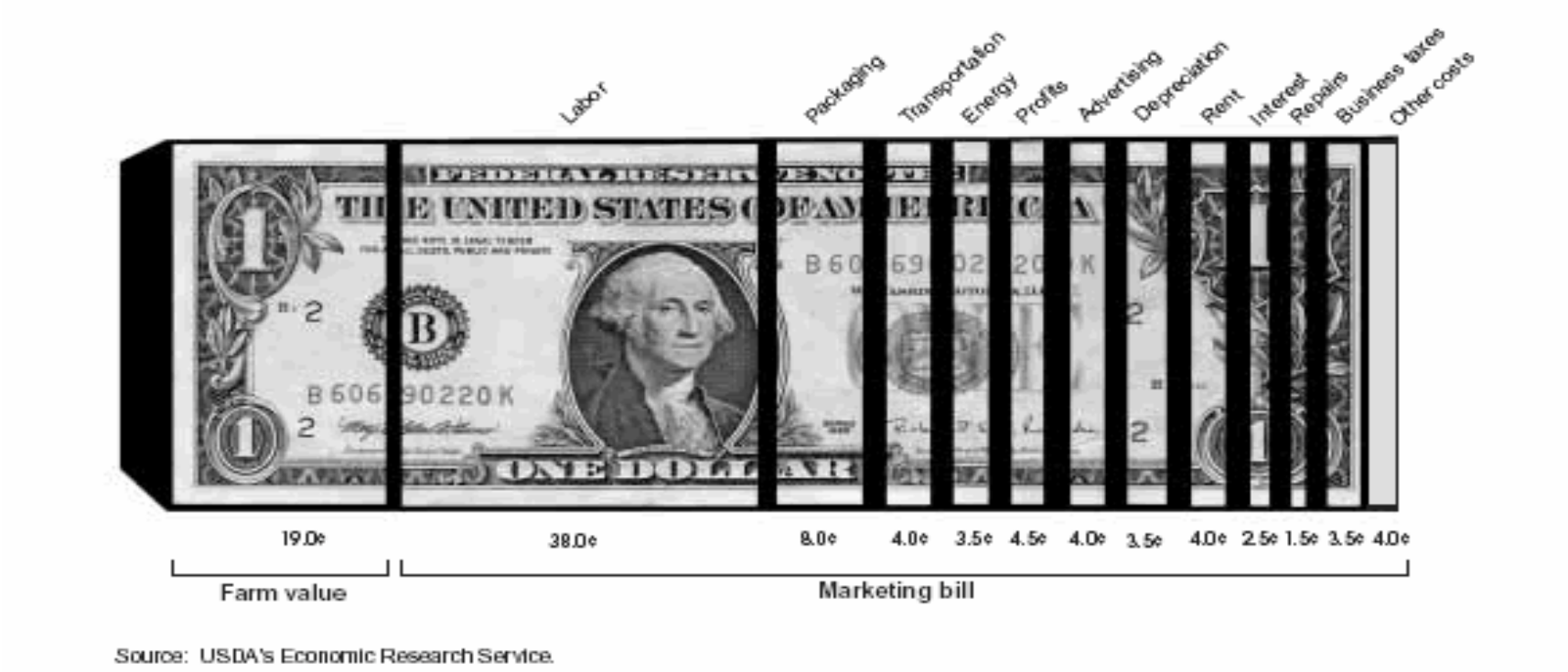



Figure A17 **Added value in different industries beyond the farm gate**

# Horticultural producers can potentially add value to their operations by re-configuring their supply chain

Opportunities to further add value for Organic production




Source: USDA's Economic Research Service.

# Establish a culture of sustainability in the holistic approach of CerOrganic products

- Needs for holistic approach of all steps involved in the PH food chain (harvest, packaging, storage, transportation, distribution)

- growers, handlers, wholesalers, retailers and consumers of organic food products

# Sustainability embraces full product life cycle

Harvesting

Storage

Packaging

Transportation


Distribution
Wholesale
Retailers

Waste

Consumers

Disposal &
recycling

Cultivation
(primary production)

# Establish Sustainable standards in postharvest handling operations

http://www.scscertified.com/docs/SCS_STN_SustainAgStandard_V1-1_082009.pdf

# Consider the retailer and consumer views

## in terms of:

- pollution (Consumers more conscious of environmental issues)
- energy cost
- carbon footprint
- low input of water source
- Reduced PH losses

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# Guidelines to maintain quality and improve safety of CerOrganic products

## Guidelines in connection with Good Agricultural Practice (GAP) to study the postharvest handling procedures for the maintenance of quality and safety of CerOrganic products

- POSTHARVEST HANDLING FOR ORGANIC CROPS
- ASSESSMENT OF POST-HARVEST PRACTICES FOR FRUITS AND VEGETABLES IN JORDAN
- QUALITY MAINTENANCE AND ENHANCEMENT THROUGHOUT THE FRESH FRUITS AND VEGETABLES CHAIN
- GOOD AGRICULTURAL PRACTICES AND POSTHARVEST HANDLING PRACTICES
- The Return on Investment in Postharvest Technology for Assuring Quality and Safety of Horticultural Crops

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# The need for standards on Requirements for post-harvest handling of organic horticulture produce

Various standards applying by Organic associations

Assessment guidelines:


1. Demonstrate knowledge of the requirements for post-harvest handling of horticultural produce
2. http://www.biodynamic.org.nz.
3. http://www.bio-gro.co.nz.
4. http://www.nzfsa.govt.nz/organics.

Example

## NATIONAL (Israel) STANDARDS

## FOR ORGANICALLY GROWN PLANTS AND THEIR PRODUCTS

# PROCESSING AIDS

Substance Specific conditions

- Water
- Calcium chloride Coagulation agent
- Calcium carbonate
- Calcium hydroxide
- Calcium sulphate Coagulation agent
- Magnesium chloride (or nigari) Coagulation agent
- Sodium hydroxide Citrus fruits, olives
- Potassium carbonate Drying of grape raisins
- Carbon dioxide
- Nitrogen
- Ethanol Solvent
- Tannic acid Filtration aid
- Egg white albumin
- Casein
- Gelatin
- Isinglass
- Vegetable oils Greasing or releasing agent
- Silicon dioxide As gel or collodial solution
- Activated carbon
- Talc
- Bentonite

http://www.science.co.il/Agriculture/National-Standards-Organic.pdf

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# Certification

## The organic certification as a potential tool to improve marketing of organic products


1. "Organic" Foods: Certification Does Not Protect Consumers
2. NATIONAL STANDARD FOR ORGANICALLY GROWN PLANTS AND THEIR PRODUCTS
3. Declaration of Sustainability in the Organic Food Trade

EPA http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5087112

# 2. Define the targets of sustainable Postharvest (PH) handling system to keep fruit quality and at the same time meet the commitment for the environment (improve energy efficiency, decreasing the carbon footprint) and optimize the food safety.

# 2. Targets of sustainable Postharvest (PH) handling of CerOrganic products

1. Maintain PH quality for CerOrganic production
2. Reduce PH losses
3. Waste reduce or eliminate
4. Efficient use of energy and water
5. Safety for growers, handlers, sailers and consumers
6. Incorporate the carbon footprint in the marketing

http://www.regionforward.org/sustainability-target-seven
Sustainability in agriculture—an evaluation of principal goaloriented concepts to close the gap between theory and practice

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# 1. To maintain quality
# Implement sustainable postharvest technology
# (harvesting, packaging, storage, transportation, wholesale, retain marketing)

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# Sustainable storage methods of fruits and vegetables

# Reasons why some organic growers do store

- Continuity of supply to their customers
- Maintain crop quality
- Consumers wish to know how and where their food is grown and that it has been grown locally and then stored
- To provide a regular income and thus avoid cash flow problems.
- To provide work for their staff all through the year.
- To avoid oversupply and saturation of the market
- To accumulate produce for peak periods of demand.

# Sustainable approach for packaging of organic products

- Implement a zero-waste approach to packaging:
- reducing the amount of packaging we use,
- actively participating in the development of packaging that is reusable, recyclable, and/or biodegradable,
- considering packaging material contents when making all purchasing decisions,
- collaborating with buyers and suppliers on creative solutions which eliminate unsustainable packaging throughout the value chain

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# Sustainability of Transportation of Market Horticultural Crops

Modes of transportation for conventional products:

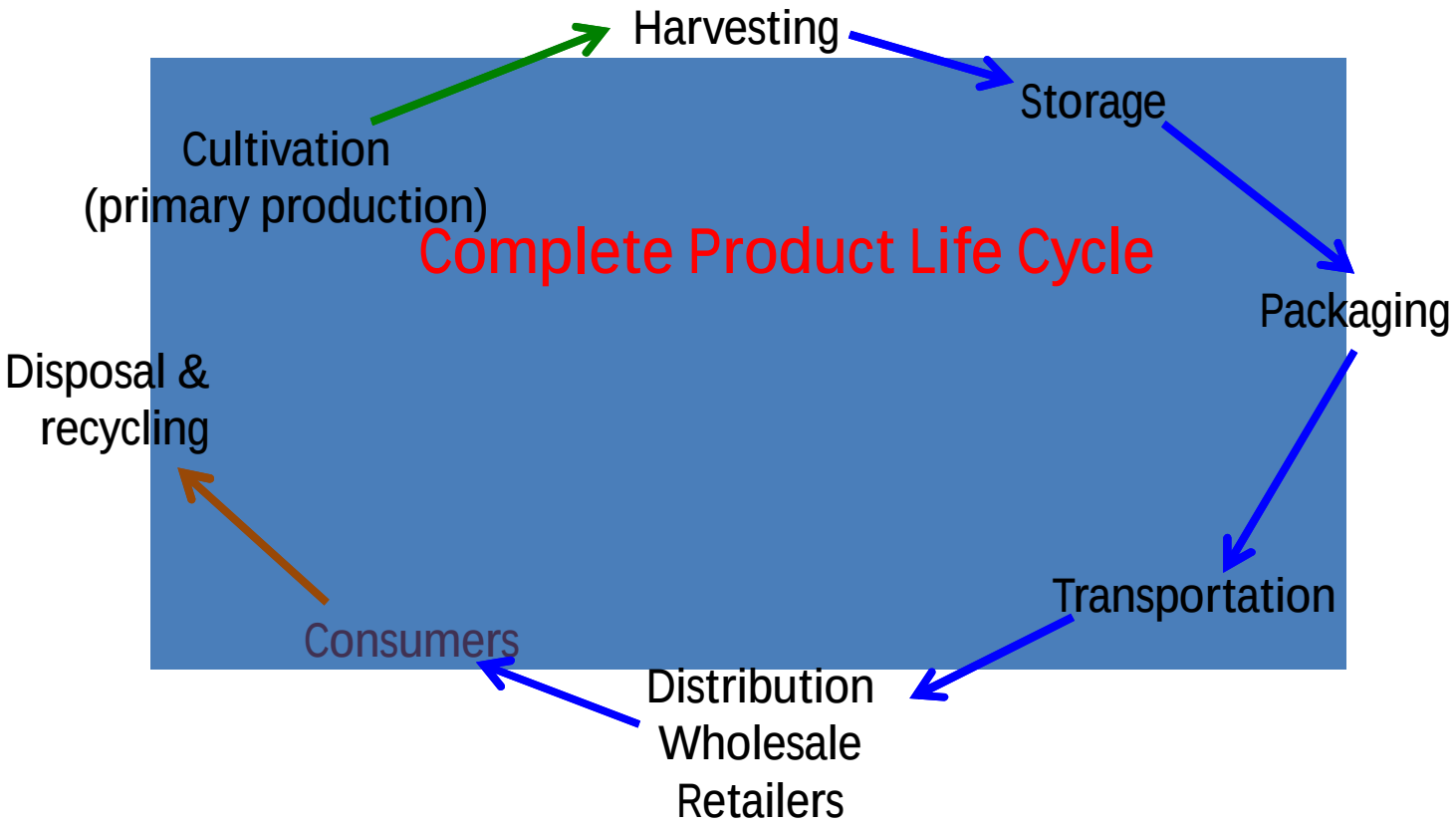
- Airplanes
- Railroads
- Ships (marines)
- Trucks
- Combinations

# In strategic planning Demonstrate knowledge of the requirements for post-harvest handling of horticultural produce

# Commitments to the Environment

- Reduce impact on GHG (Green House Gas)
- Protect natural resources
- Waste reduction
- Preservation of water
- Preservation of biodiversity
- Low carbon footprint for Complete Product Life Cycle (CPLC) of each product

# The need for the carbon footprint consider the CPLC



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# Reduce post-harvest losses due to Post harvest disorders

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# Guidelines to reduce PH losses due to physiological disorders



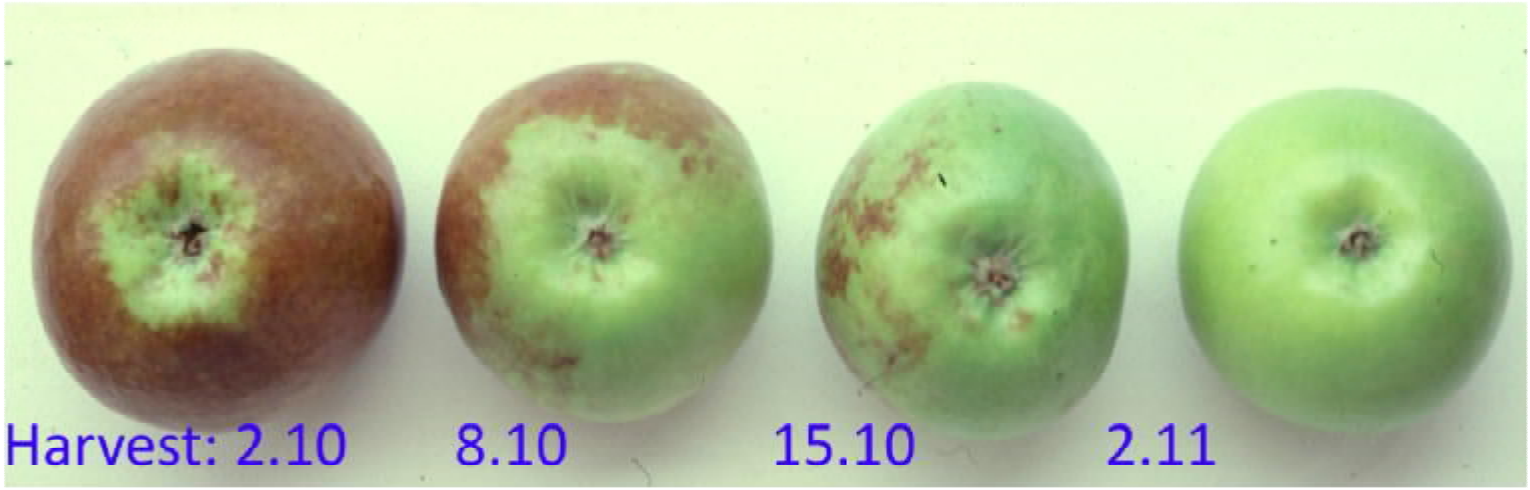
- Identify and locate the cause of the disorder (stresses-temperature, ethylene, CO2, O2, nutritional, mechanical et).
- Avoid locations which predispose the crop to the particular disorders (chilling temperatures, heat stress, low Ca, excess of nitrogen in the soil et).
- Consider the pre-harvest conditions (temperature, chilling hours).
- Correct the conditions to avoid the incidence of the disorder.
- Implement the appropriate strategies and develop handling protocol for each specific organic product.
- Improve the handling system and implement new technologies to overcome the constrains.
- Apply training program for handlers to have access to the Internet numerous websites

# Example 1: Reduce PH physiological disorders of apples by implementing the sustainable approaches:

- For Bitter pit apply pre-harvest $Ca^{++}$ sprays
- For superficial scald use alternative methods:
  - Avoid susceptible cultivars
  - Late harvest low incidence of scald
  - Avoid plain areas with low pre-harvest chilling temperature preferably apples from mountain areas with chilling temperatures >100hrs (1)
  - For long storage apples use CA or ULO storage
  - Apply heat treatments
  - MAP reduces scald

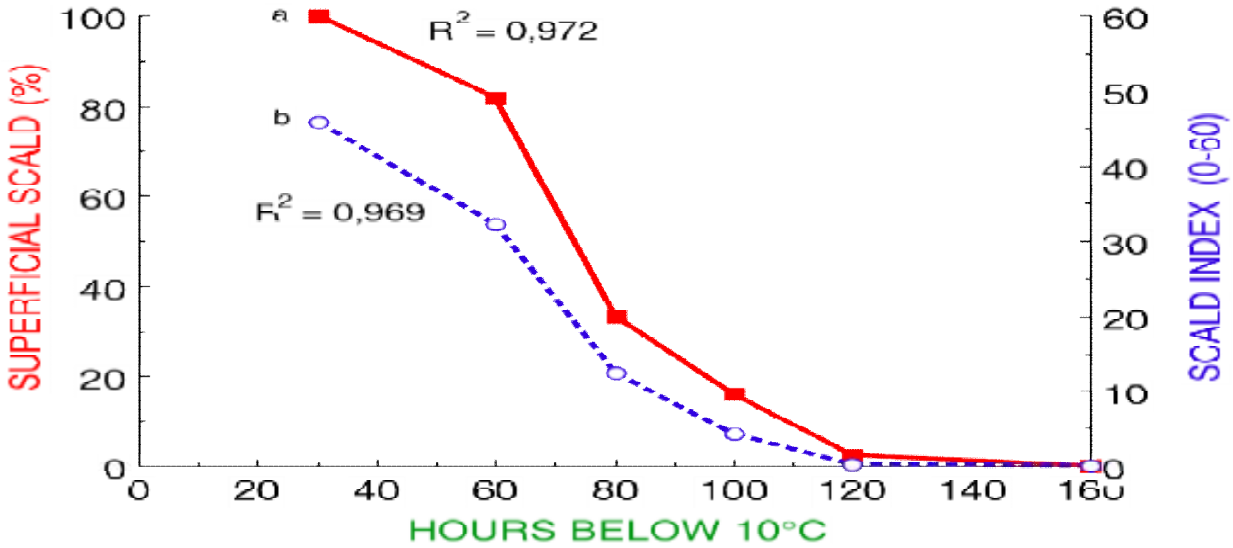

1. Effects of low preharvest temperature on scald susceptibility and biochemical changes in 'Granny Smith' apple peel
2. Preharvest chilling reduces low temperature breakdown incidence of kiwifruit
3. Bitter Pit Prediction in Apples and the Commercial Use of Fruit Magnesium Infiltration

# Superficial scald




Cause:
early harvest of apples in low altitude (plain) areas
(Preharvest chilling conditions are important to reduce scald)
Cultivars sensitive.

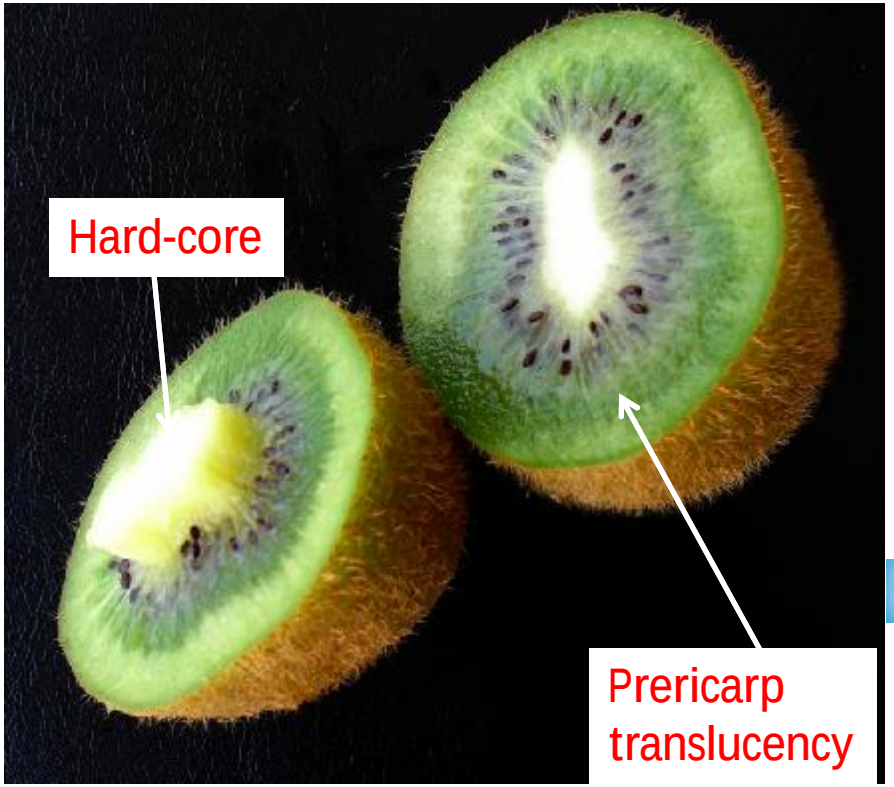
# Chilling hours to overcome the scald problem (mountain /plain locations important)




# Example 2. **Physiological disorders of kiwifruit pericarp translucency and hard-core**

Cause of the disorder:

- Low preharvest chilling temperatures (2)
- Early harvest < SSC 6.2%
- high $CO_2$ >8% (1),
- Storage temperature < -0.5ºC (3)
- Presence of ethylene (1)




To avoid:

- Delay harvest to accumulate chilling hours (2) harvest the fruit with SSC > 6.5%
- Avoid accumulation of $CO_2$ < 4-5%
- Store at temperature above 0ºC


1. http://postharvest.ucdavis.edu/Produce/ProduceFacts/Fruit/kiwi.shtml
2. Preharvest chilling reduces low temperature breakdown incidence of kiwifruit
3. Non-freezing points below zero induce low-temperature breakdown of kiwifruit at harvest

# Example 3: Reduce PH **physiological disorders** of onions and potatoes by implementing the sustainable approaches:

- For potato or onions sprouting use alternative to chemical growth inhibitors

use alternative methods:

- Select cultivars with big dormancy
- Store in temperature above 4-5ºC (below 4-5ºC starch **à** sugars (inducing acryl amine)
- Store at low temperatures + continues exposure to 10ppm $C_2H_4$ (4) Ethylene inducing the conversion of starch to sugars)
- Use natural sprout inhibitors (Hydrogen per oxide, essential oils, BIOX-M) (1,2,3)
- For some cultivars use CA storage

1. Organic and Alternative Methods for Potato Sprout Control in Storage
2. ORGANIC POTATO PRODUCTION AND STORAGE
3. ENVIRONMENTALLY FRIENDLY METHOD FOR THE CONTROL OF SPROUTING AND TUBER-BORNE DISEASES IN STORED POTATO
4. Potato and onion sprout control goes eco-friendly

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# Reduce post-harvest losses due to Post harvest diseases

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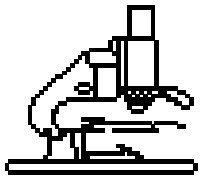
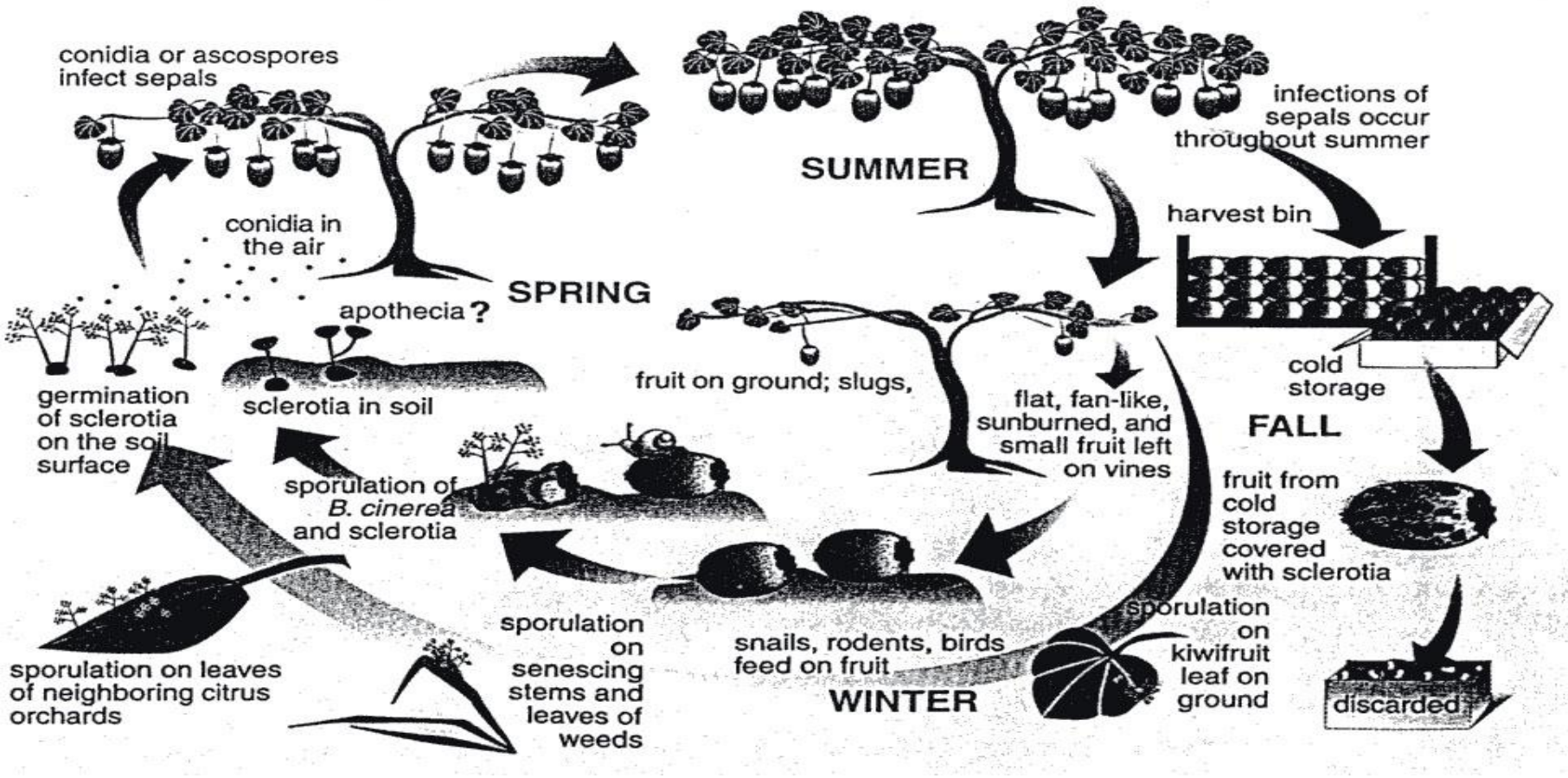
# Guidelines to reduce PH losses postharvest pathogen



- Identify and locate the cause of the disease or spoilage
- Know the lifecycle of the pathogen
- Use PH handling techniques that enhance the natural mechanism of host resistance (e.g. curing)
- Reduce the initial inoculum
- Eliminate the use of synthetic phytochemicals.
- Use alternative methods to overcome the problem of pathogen loss
- Use approaches that guarantine for safety of workers, sailers and consumers

# Know the life cycle of the pathogen

## Example: **Life cycle of *Botrytis cinerea in kiwifruit***



# Gray mold rot *(Botrytis cinerea)*



# Curing is important to reduce PH diseases

Curing is a process that is encourages the product to naturally heal its own wounds.

Apply curing in:

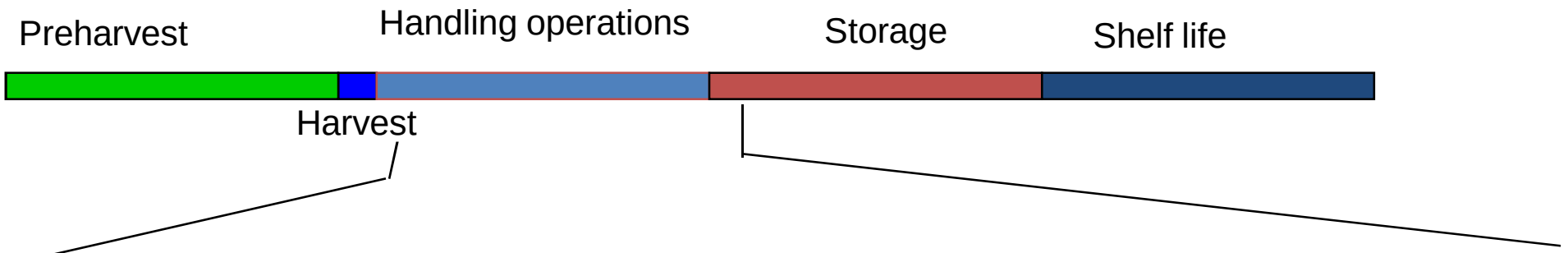
Kiwifruit (1)

Potatoes (2)

Onions (3)

1. NEW PROCEDURES FOR "CURING" AND CONTROLLED ATMOSPHERE (CA) STORAGE TO CONTROL BOTRYTIS CINEREA IN KIWIFRUIT
2. Potatoes: Handle with care.
3. Curing & Drying onions

# Postharvest Disease and Disorder management in conventional PH handling




## In the packinghouse

to minimize fungal infections use

EPA Fumigants

to minimize physiological disorders

Use alternative methods

# Reduce the initial inoculum In the orchard

In the packinghouse

# Strategy of postharvest disease control

## Prevention of infection

Reduce the number of injuries and of pathogen propagules

Sources of inoculum:

- containers
- water for postharvest handling operations
- the atmosphere of the packinghouse
- brushes and conveyor belts

# Postharvest disease suppressions by MAP

## Examples: Strawberries

An initial charge of $CO_2$ plus the produced by respiration served to maintain the $CO_2$ - enriched concentration of $CO_2$ during transit of film-covered pallets of California strawberries

Incidence of decay at 15°C was lowest when $CO_2$ concentration upon arrival were >10% and transit temperatures were < 3°C.

Combining preharvest fungicidal sprays-applied during the flowering season-with suitable PVC wraps almost eliminated pathological deterioration during prolonged storage

# Implement the hurdle concept to reduce PH pathogens

hurdle technology

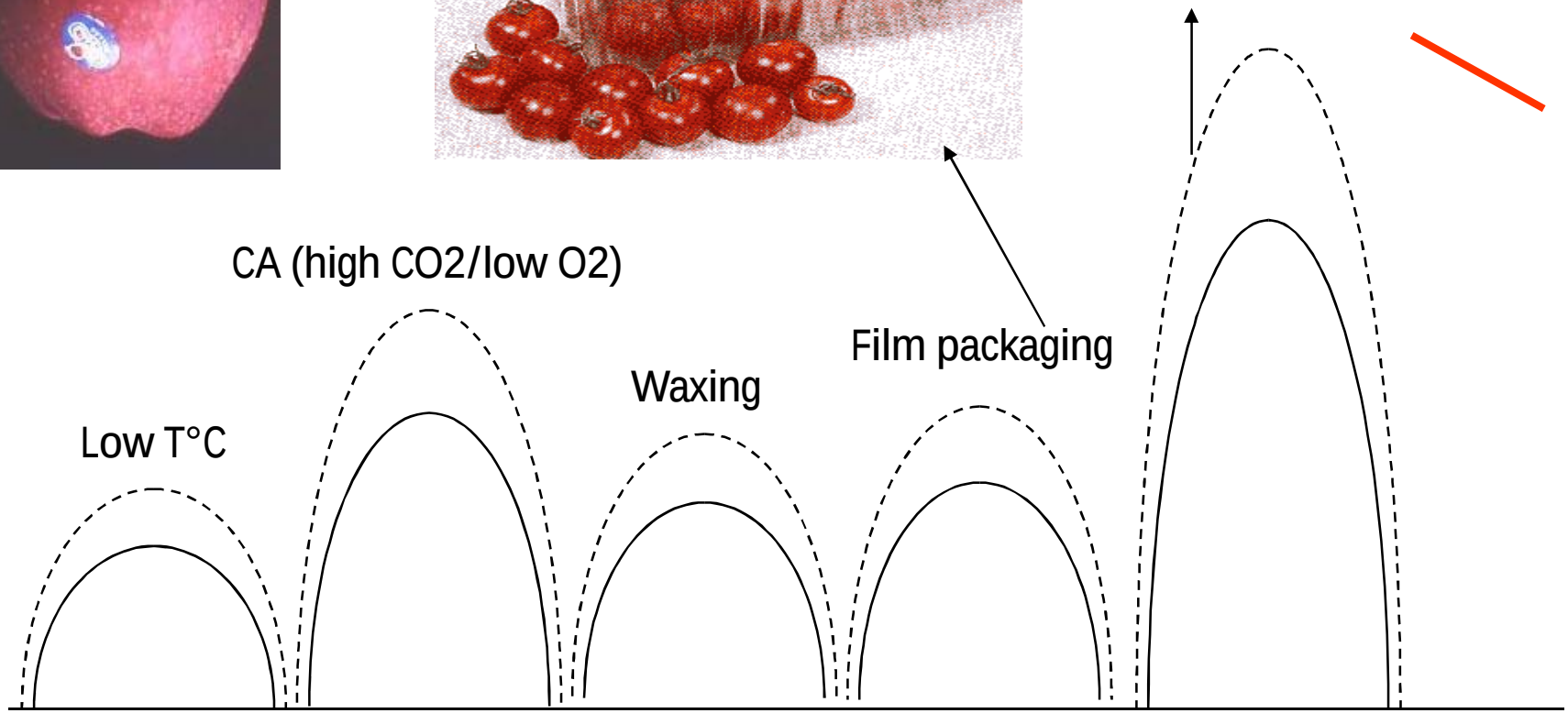
# The hurdle concept to control PH diseases & disorders

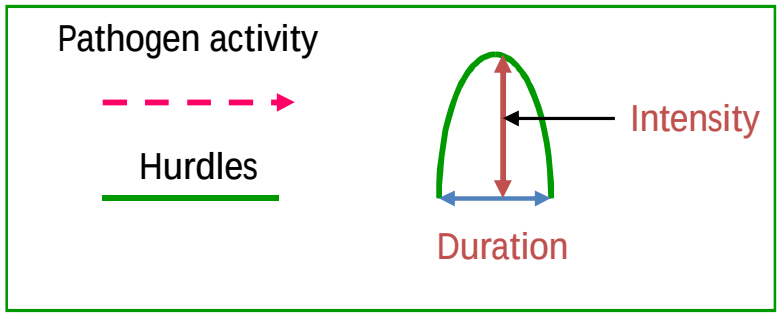
Hurdle technology (also called combined methods or barrier technology) advocates the combination of the existing and novel preservation techniques in order to establish a series of preservative factors (hurdles or barriers) that any pathogens present should not be able to overcome.

The "higher the hurdle, the greater the effort.

Because of their concerted, sometimes synergistic effect, the individual hurdles may be set at lower intensities than would be required if only a single hurdle were used at the preservative technique.

# Barriers during postharvest handling

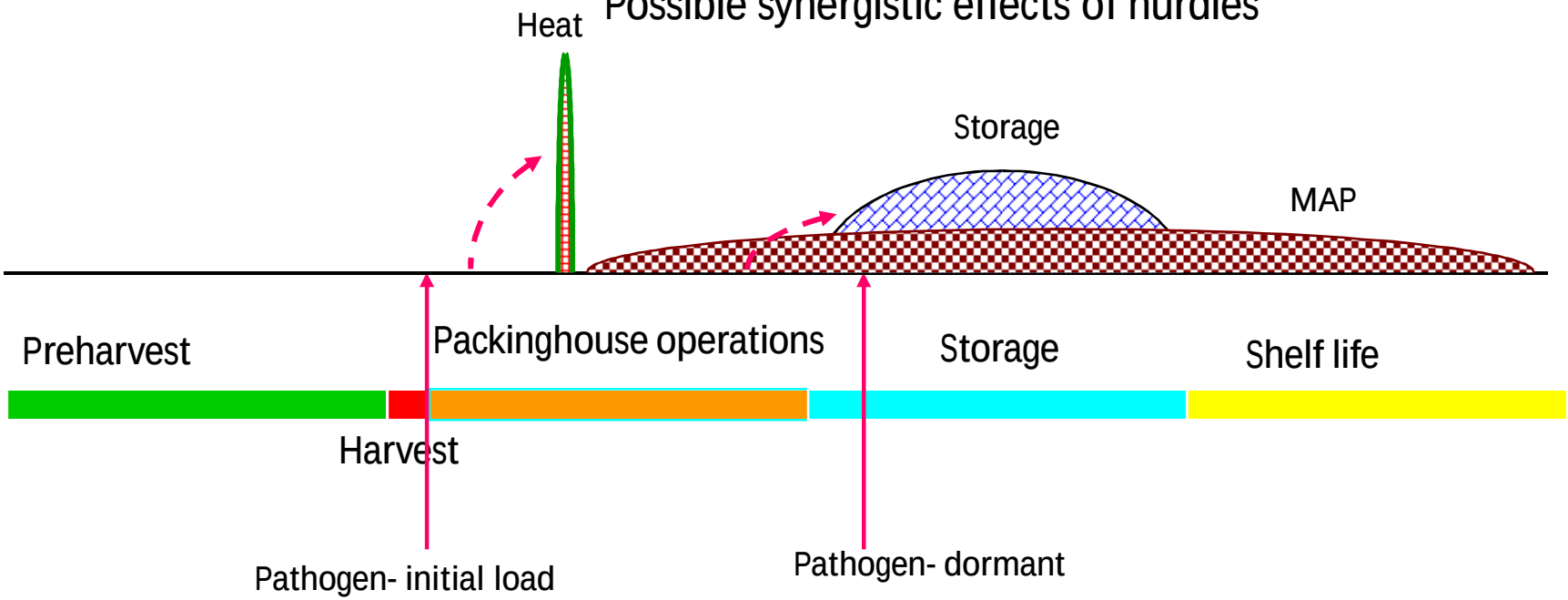





Example: The pathogen present in the packinghouse does not overcomes ("jump over") the heat hurdle and the MAP and storage hurdles

## Combination of small alternatives hurdles

Possible synergistic effects of hurdles



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# Waste in postharvest handling operations

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# Recycling waste products composting

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# **Example:** Waste management of organic olive processing factory

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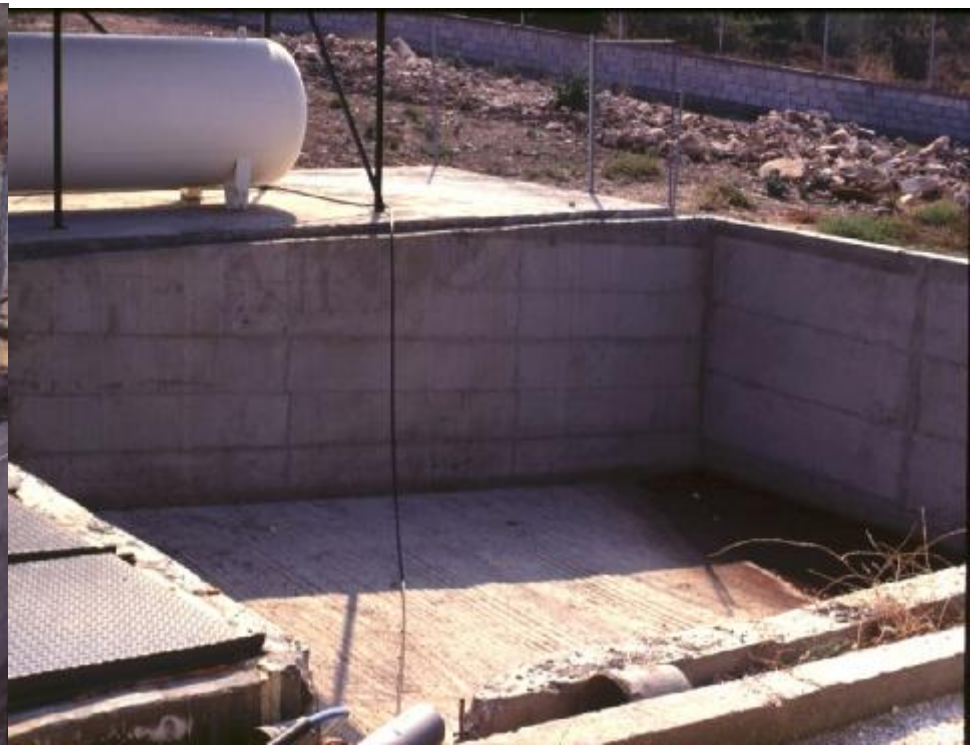
- Biodegradation



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# Compost from olive leaves

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# Compost from olive leaves ready to use as organic fertilizer

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# Compost ready to use as organic fertilizer in olive orchards

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# A unit to produce compost from a peach processing factory

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# Food safety in postharvest handling operations

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# Food safety

## Optimization of Food Safety for Organic Post Harvest Handling of Foods

1. Post-Harvest Produce Handling What You Can't See Can Make You (and your customers) Sick
2. Overview of Human Pathogens in Produce
3. Optimization of Food Safety Programs For Organic Post Harvest Handling of Foods
4. Water Quality, Food Safety and Agriculture
5. Employee Practices & Food Safety
6. http://www.ccof.org/pdf/food safety/Using Sanitizers on the Farm.pdf
7. Harvest/post-harvest handling and Food Safety

# Safety

## Treatments to reduce microbial contamination

- Prevention of microbial contamination
- growers, packers or shippers should use GAP and GMP
- Avoid contamination from human or animal feces, animal manure or municipal biosolid wastes used as fertilizers
- Use clean-disinfected water
- Use sustainable sanitizer (ozone, hydrogen
- peroxide) in water in order to kill microbes

http://economics.ag.utk.edu/hbin/2006/Organic%20produce%20handling.ppt
The Return on Investment in Postharvest Technology for Assuring Quality and Safety of Horticultural Crops

There are many opportunities for fresh produce to be contaminated by farm workers

# Farm Worker Hygiene

Courtesy of Trevor Suslow

# Field Sanitation


***Clean harvest containers and tools daily.***

# Ozone use in postharvest

- Ozone is a very powerful oxidizer, similar to chlorine but about 200X stronger. This gives it the ability to break down and kill bacteria, mold and fungus spores.
- Among its disadvantages are:

  a half-life of only 15 minutes;

  it needs thorough mixing to be effective; and a high oxidation potential.

  Ozone 'eats' many common materials, like rubber and mild steel, which tends to push you into stainless steel, expensive stuff.

1.http://www.ozomax.com/pdf/post-harvest-disifection.pdf
2.Approved Chemicals for Use in Organic Postharvest Systems
3.Postharvest oxidative stress in horticultural crops
4.USE OF OZONE IN STORAGE AND PACKING FACILITIES
5.ozone for postharvest use

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# Energy efficiency in postharvest handling operations

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# ENERGY use in PH handling operations

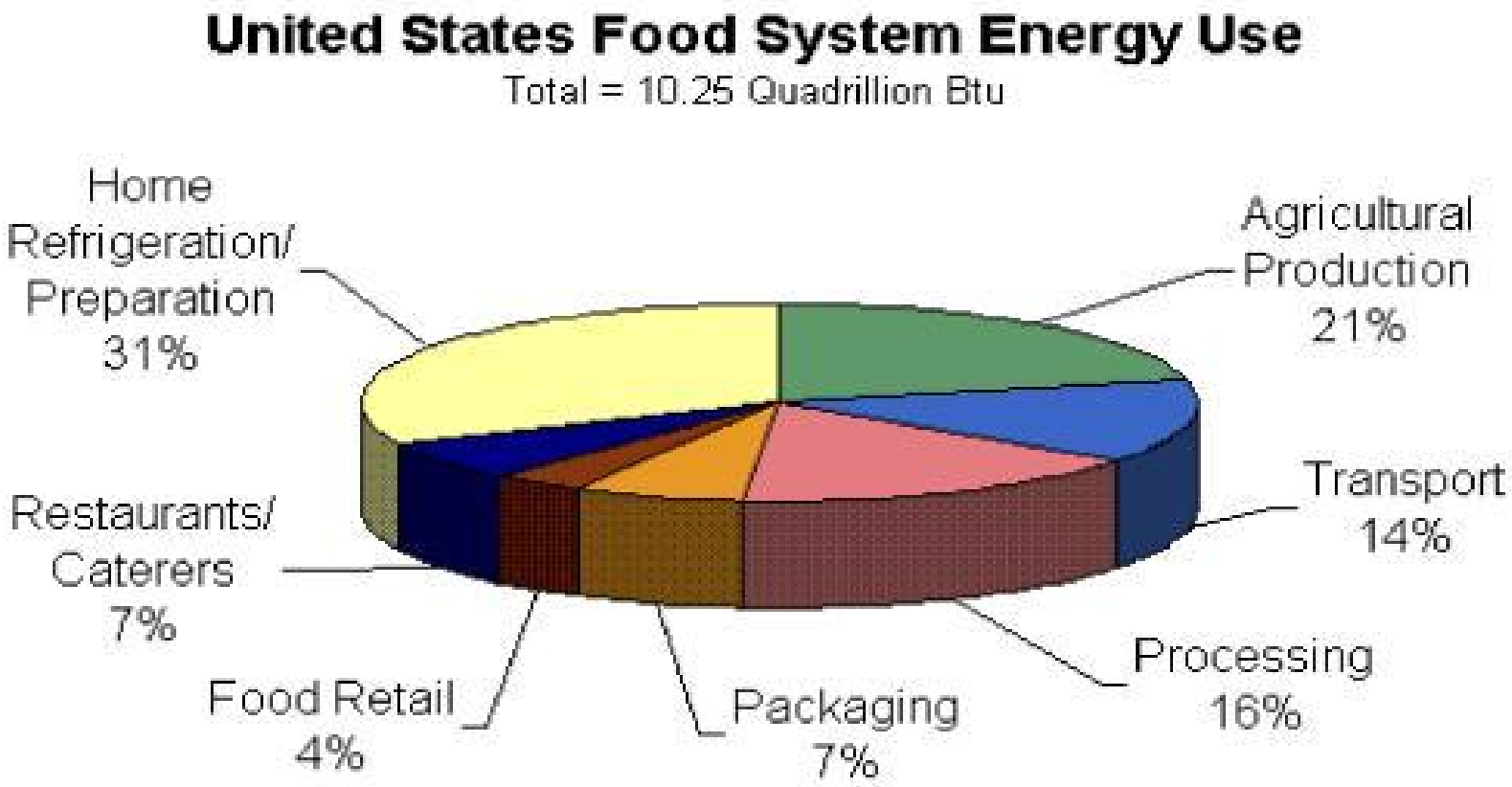
Methods to

keep fruit quality

and at the same time to improve energy efficiency in comparison to traditional storage

- decreasing storage costs
- decreasing carbon footprint

# Energy Use




1. The Energy Embedded in Our Food
2. Sustainable Postharvest Handling

- Input of energy in postharvest handling (1,2)
- Energy saving in fruit storage (3,4, 5, 6)

1. Energy use in organic food systems
2. Sustainable Postharvest Handling Energy Conservation in Apple Storages
3. Energy Efficiency Opportunities in Fresh Fruit and Vegetable Processing/Cold Storage Facilities
4. Comparing domestic versus imported apples: a focus on energy use
5. Energy conservation measures in the fruit and vegetable processing

# ENERGY USE OF COMMERCIAL FORCED-AIR COOLERS FOR FRUIT

Strawberry cold storage room with unused space

# Energy efficiency in organic/conventional production

Organic systems consistently demonstrate greater energy efficiency / land unit and unit of production compared to conventional operations. These positive results are usually attributable to the absence of synthetic fertilizers, particularly nitrogen, and synthetic pesticides.

Organic systems produce fewer emissions per unit area and unit of production

# Energy conservation in PH handing operations



## GUIDELINES FOR IMPROVING ENERGY EFFICIENCY

- Undertake regular energy audits to identify energy saving potential
- Sensitize plant personnel on the benefits of energy conservation
- Encourage people to provide ideas for energy savings and reward them
- Promote group activities for information sharing at cluster level
- Search constantly for energy-efficient technological solutions
- Avail external expertise to develop and undertake technological up gradation
- Participate in workshops and training programs on energy efficiency improvements
- Share success stories and discuss energy efficiency improvement strategies
- with co-entrepreneurs

# Transportation of Organic Market Horticultural Crops

In terms of energy use and cost consider:

- New method of transport
- Local products are favored
- Local supplies are favored




# The demand for making the carbon footprint smaller

- Postharvest technology can make a significant contribution to reducing the carbon footprint of food systems.
- Harvesting products during the cooler parts of the day and avoiding exposure to the sun after harvest through the use of shade materials will reduce the heat load that must be removed from the product.
- Energy for cooling can be reduced by using efficient cooling operations and managing them well. Maintaining the cold chain once the product has been thoroughly cooled will prevent the need for re-cooling and reduce energy use.
- Manipulation of postharvest atmosphere (CA and MAP) for preservation of quality.
- Reducing wasted food is something everybody can do to reduce the greenhouse gas emissions in our food system.

http://www.growingproduce.com/americanfruitgrower/?storyid=62
Improving Energy Efficiency and GHG Mitigation Potentials in Canadian Organic Farming Systems

# Sustainable energy use



Supplementary measures:

## Alternative energy use

- solar systems
- wind power
- others methods

# Sustainable water use

Reduce the use of fresh water and optimize the operations to be so that water use is as efficient as possible

# Waste

Reduce waste at the source and treat waste in a way that sustains all living systems:

Reusing, donating, recycling, and composting.

Utilize environmentally sound disposal systems.

Redesign the operations so that eventually “waste” will be eliminated because all material will become the raw material for new products and uses.

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# Sustainability embraces full product life cycle

Waste

Waste

Recycling

Harvesting

Cultivation
(primary production)

Storage

Packaging

Disposal &
recycling

Transportation

Consumers

Distribution
Wholesale
Retailers


http://www.biodynamic.org.nz/

Waste

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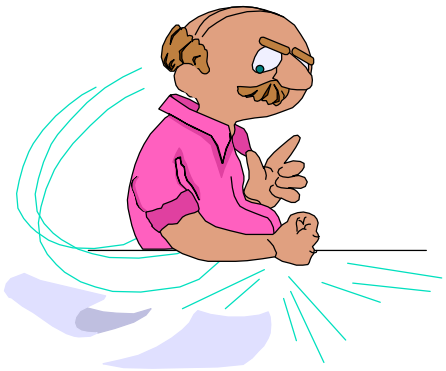
# Part III.
# Implementation of sustainable PH technology
# (From theory to praxis)



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# Harvest Handling

- Quality cannot be improved after harvest
- Harvest at proper stage and size
- During the coolest part of day
- Keep in shade
- Handle gently (moisture loss may be as much as 400% by single blemish)

# Apply maturity indices to determine the harvest time

- Soluble solids content
- Dry weight)

Firmness measurements

# Post Harvest and Storage Consideration

1. Temperature
2. Packaging
3. Chilling injury
4. Preventing weight loss
5. Sanitation
6. Ethylene
7. Mixed loads
8. Storage of crops

# 1. Temperature Single Most Important Factor

Refrigeration retards:

- Aging
- Undesirable metabolic changes
- Moisture loss
- Spoilage from bacteria, fungi and yeasts
- Undesirable growth, i.e. sprouting

# 1.1. Pre-cooling

- First important step
- To lowest safe temperature ASAP - critical for crops with high respiration rates:
  - Broccoli
  - Asparagus
  - Green beans
  - Mushrooms
  - Sweet corn

# 1.2. Room Cooling

- Not as efficient as some other methods
- Good as a pre-cooling method
- Need good air circulation around containers

# 1.3.Forced Air Cooling

- Cooling rate depends on air temperature and rate of air flow
- Generally 75-90% faster cooling

Note: *to avoid over cooling and dehydration, do not operate forced air fans after produce has been cooled to correct temperature*

# 1.4. Forced Air Cooling

- Cooling rate depends on air temperature and rate of air flow
- Generally 75-90% faster cooling

Note: *to avoid over cooling and dehydration, do not operate forced air fans after produce has been cooled to correct temperature*

# 1.5. Top or Liquid Icing

- Especially effective on dense products and palletized products difficult to cool
- Works well on high respiration products: sweet corn, broccoli
- One kg of ice cools ~three kg of produce

# 1.6. Hydro-cooling

- Very efficient method of cooling (removes heat 5 times faster than air but less energy-efficient)
- Can serve as a means of cleaning
- Reduces water loss
- Chlorinate to reduce microorganisms
- Not appropriate for: berries, potatoes, bulb onions, others not suited to wetting

# 1.7. Vacuum Cooling

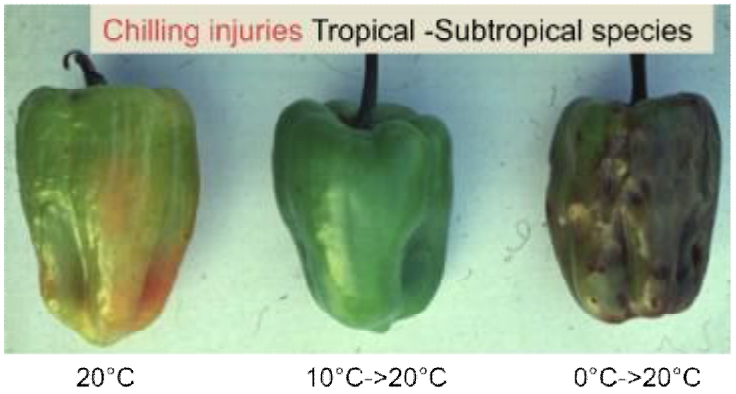
- Water leaves crop and take heat with it
- Produce sprayed with water first = “Hydrovac Cooling”
- Good for leafy vegetable which have a high surface-to-volume ratio, i.e. greens

# 2. Packaging

## (avoid damaging the crop)

# 3. Chilling injuries

## APPLY PROPER STORAGE TEMPERATURE TO AVOID CHILLING



# 3.1. Chilling Injury

- Some vegetables best stored just above freezing
- Others best stored at 7°C-12°C
- Both time and temperature involved
- Effects of chilling injury are cumulative

# 3.2. Chilling Injury

- Moderately sensitive:
  - Snap beans
  - Cantaloupe
  - Peppers
  - Winter squash
  - Tomatoes
  - Watermelon

# 3.3. Chilling Injury

- Very sensitive crops are:
  - Basil
  - Cucumber
  - Eggplants
  - Pumpkins
  - Summer squash
  - Okra
  - Sweet potatoes

# 4. Preventing weight loss

Weight loss due to:

- Transpiration
- Respiration

# 4.1. Preventing Moisture Loss

- Important in controlling moisture loss
- Best range 80 -90% R. H.
- Difficult for small producers
- Sanitation becomes even more critical
- Cool temperature important
- Use a hygrometer to measure

# 4.2. Reduce weight loss (due to transpiration)

To minimize water loss include the following:

- a. Curing of certain root vegetables, such as garlic, onion,
- potato and sweet potato.
- b. Waxing and other surface coatings used on some
- used on some commodities, such as apple, citrus
- fruits, nectarine, peach, plum, pomegranate and tomato.
- c. Packaging in polymeric films that act as moisture
- barriers.
- d. Careful handling to avoid physical injuries, which
- increase water loss from produce.
- e. Addition of water to those commodities that tolerate
- misting with water, such as leafy vegetables.

# 5. Sanitation

- Pathogens traced to fresh fruit and vegetables:
  - *E. coli* 0157:H7
  - *Salmonella*
  - *Cryptosporidium*
  - *Hepatitis*
  - *Cyclospora*

  Chlorine is most often used

  Caution – organic growers, it is a restricted material

  Alternatively use:
  - Ozone
  - Hydrogen peroxide

# 6. Ethylene

- Natural hormone produced by some fruits
- Damaged fruit produces more
- Do not store ethylene producers with fruits and vegetables that are sensitive
- Ethylene producers: apples, cantaloupes, peaches, pears, plums, tomatoes

# 7. Mixed Loads

- Combine only products that are compatible with respect to:
- TEMPERATURE
- Relative humidity
- Oxygen and carbon dioxide
- Protect from odors
- Ethylene protection

1. Modified atmosphere packaging for mixed loads of horticultural commodities exposed to two postharvest temperatures
2. Transport and handling of perishable products in remote areas of South Australia
3. Mixed Loads

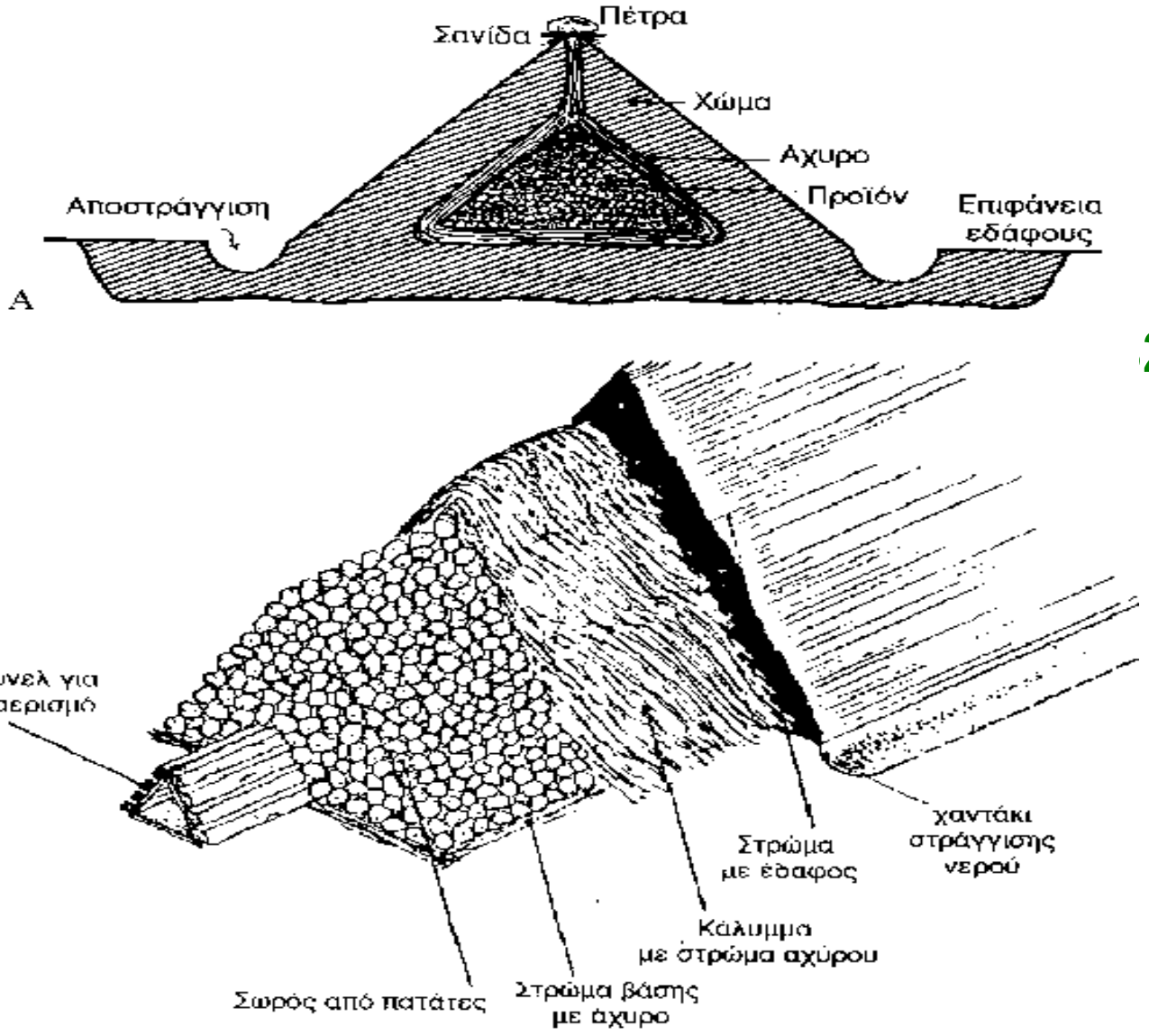
# 8. Implement Storage methods

- Field storage
- Cellars
- Pits
- Clamps
- Indoor ambient air cooled storage
- Refrigerated cool stores
- Controlled atmosphere storage

# 8.1 Field storage

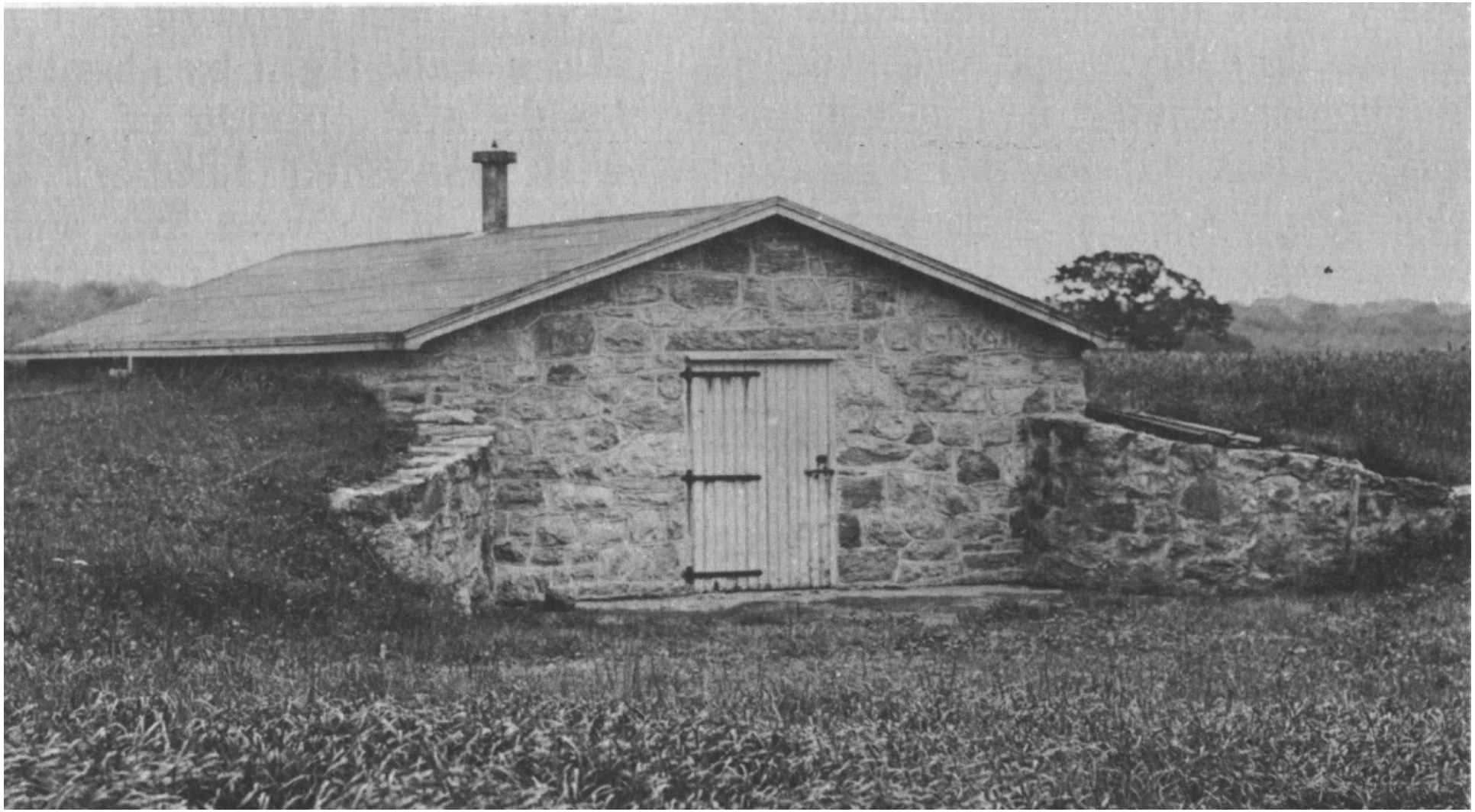
Storage oranges on the tree

Storage avocados on the tree

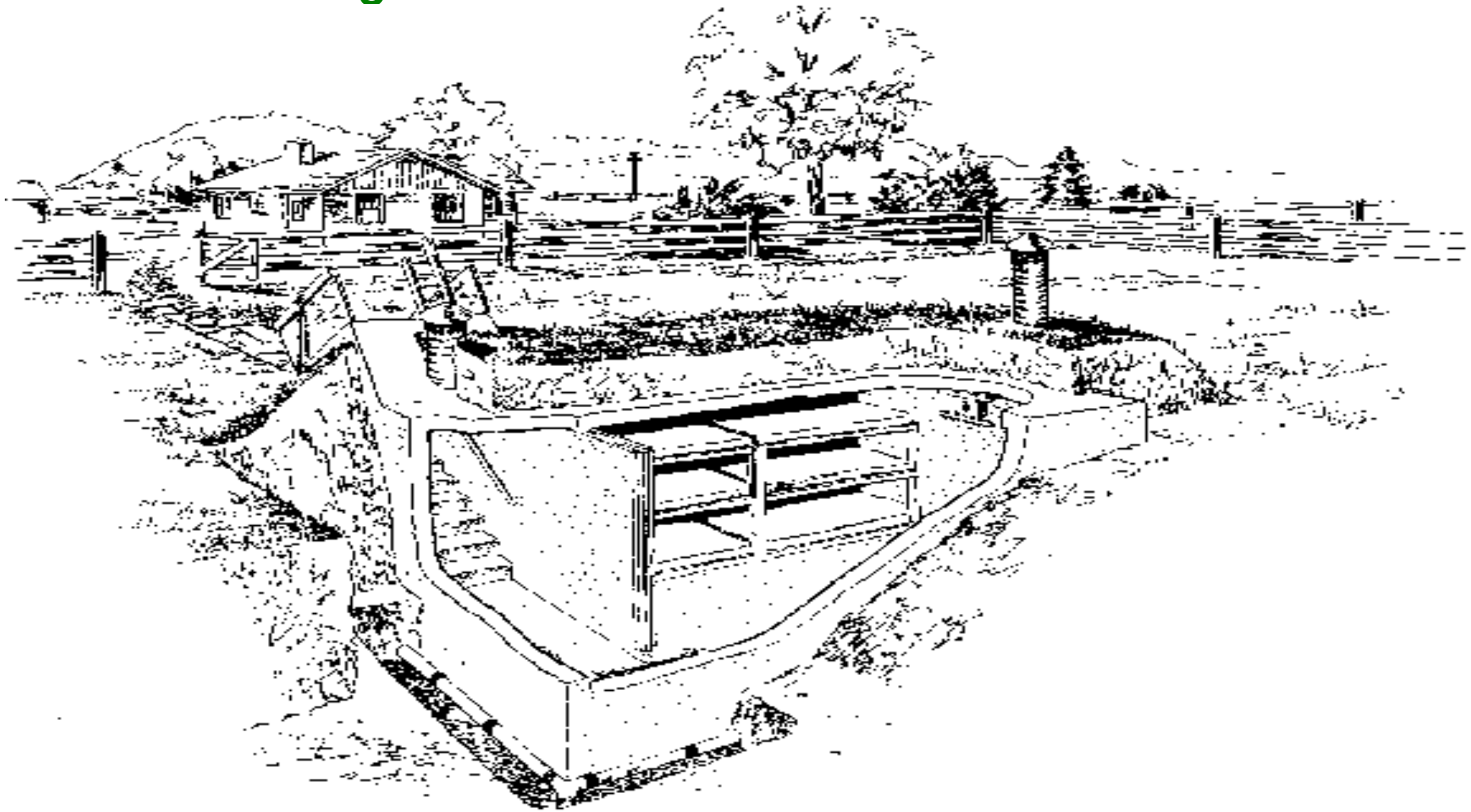



## 2. One-shaped pit for potato storage

# 8.3 Partly underground cellars



# 8.4. Underground



# 8.5. Mechanical refrigerated

# 8.6. Controlled atmosphere storage

# For long storage use CA or ULO storage

Control ULO 0,7% $O_2$ ULO 1% $O_2$

The effect of CA and ULO storage in scald

# 1. STORAGE OF ORGANIC FIELD VEGETABLE AND POTATOES

# 2. STORAGE OF ORGANICALLY PRODUCED CROPS

# Storage of organic fruits (apples, pears)

Many post-production operations for organic produce are identical to non-organic production. However the storage of organic fruits would pose serious problems. Refrigerated storage will keep most varieties of apple until November/December. The permitted use of controlled atmosphere storage needs to be considered for longer storage periods.

PH diseases and physiological disorders such as superficial scald and bitter pit could also be potential problems. However, understanding of the causes of both physiological disorders and fungal diseases has improved and new varieties which are less prone to these problems are available. Improved storage regimes and controlled atmosphere storage can reduce losses considerably.

Sustainable Management Practices –to help to avoid storage losses

Suitable varieties

Harvest maturity

Controlled atmosphere storage

Ethylene scrubbing

# Energy use in olive oil production

The olive oil is considered as a product of energy terms (Joules) and all inputs including natural contributions (renewable and non-renewable energy sources) and economy inputs (material, services, payment, fuel, etc), as energy flow. In an emergy analysis of an irrigated organic and a conventional production of olive and olive oil in Crete here in MAICH it was found that the organic orchards was more sustainable(1). A Life Cycle Analysis (LCA) of Organic and Conventional olive oil production showed that there is a clear difference between organic and conventional production, namely a two-fold improvement of the energy efficiency in the organic production (2).

The choice of organic olive groves can decrease energy inputs without losses in production and tended to have lower $CO_2$ –emissions caused by the different uses of fossil energy (3).

1. EMERGY ANALYSIS OF IRRIGATED ORGANIC AND CONVENTIONAL PRODUCTION OF OLIVE AND OLIVE OIL IN CRETE, GREECE "PRELIMINARY STUDY"
2. ENERGY EFFICIENCY AND LIFE CYCLE ANALYSIS OF ORGANIC AND CONVENTIONAL OLIVE GROVES IN THE MESSARA VALLEY, CRETE, GREECE
3. Energy budget in organic and conventional olive groves

# Targets of sustainable Postharvest (PH) handling of CerOrganic products

- Guidelines to maintain quality and improve safety of CerOrganic products
- Implement sustainable postharvest technology (harvesting, packaging, storage, transportation, wholesale, retain marketing)
- Reducing post-harvest losses
- Develop alternative methods to overcome the constrains (pathogens) and problems (physiological disorders)
- Minimize or eliminate the waste
- Reduce energy and improve the carbon footprint

# 3. Conclusions

Considering that sustainability is a tool to add value to organic products, it is important to know how the horticultural producers can re-configuring their supply chain (from the farm to the consumer) to maintain quality and increase the competitiveness of their products. The conversion of a conventional to organic production system is not an easy task. Farthermore, it is more difficult to do this change within the umbrella of sustainability. To accomplish such a task the following **steps and measures** have to be taken beyond the farm gate:

- The idea of sustainability has **to embraces all involved** (growers, handlers, wholesalers, retailers and consumers), which follow specific standards in each step of production.
- Identify the **problems, and constrains** (PH losses, energy, waste the safety issues) to consider when decide to change from conventional to organic production.
- Establish **guidelines** and **sustainable standards** to maintain quality and improve safety of CerOrganic products.
- Implement **sustainable postharvest technology** and develop **alternative methods** to overcome the constrains (pathogens) and problems (physiological disorders).
- **Minimize or eliminate the waste**.
- Reduce energy and **improve the carbon footprint**.

# 3.i. Summary

Limited attention has been paid to the sustainable postharvest handling of organic horticultural commodities. This unit aims to provide students with the tools to critically review different management approaches for the postharvest handlers of organic crops with regards the problems and constrains when the horticultural producers decide to change their system from conventional to organic production. Emphasis is given to the PH losses, minimizing the waste and the safety and the carbon footprint issues. Sustainability in organic farming adds values to organic products and embraces all (growers, handlers, wholesalers, retailers and consumers) involved in the food chain. Implementing sustainable CerOrganic PH handling is considered to approach production in a holistic sense to includes ecological, economical and social aspects.

Examples of successful implementation of sustainable PH technology are given on handling operations (harvesting, packaging, storage, transportation, distribution) of specific products. The development of alternative methods to overcome the constrains (pathogens) and problems (physiological disorders) are discussed.

# 3.ii. References

## Basic bibliography

1. Kader, A.A., ed. 2002. Post-harvest technology of horticultural crops. Oakland: University of California, Division of Agriculture and Natural Resources Publication 3311, 535 pp.
2. Bartz and Brecht, Postharvest Physiology and Pathology of Vegetables ed. 2003. 2nd edition. Marcel Dekker, New York. 733 pp.
3. POSTHARVEST HANDLING FOR ORGANIC CROPS

# 3.ii. References

Complementary bibliography


- Suslow. T., 2000. Postharvest Handling for Organic Crops. University of California Publication 7254 8 pp.
- POSTHARVEST HANDLING FOR ORGANIC CROPS
- Organic Farming Practices: Postharvest Handling
- Food Safety and Postharvest Handling for Organic Crops

# 3.ii. References

Basic bibliography

please provide details of mandatory reference material that is provided or available from open sources

Complementary bibliography

please provide details of non-compulsary reading material

Web pages / links

please provide links to relevant / interesting web pages

# For more information on unit C534a.6

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# End